NUI Galway
OÉ Gaillimh

Autumn Examinations 2018

Exam Code(s)	4BCT, 4BP
Exam(s)	Fourth Year Computer Science and Information Technology Fourth Year Electronic and Computer Engineering
Module Code(s)	CT414
Module(s)	Distributed Systems
Paper No.	1
External Examiner(s)	Dr. J. Howe
Internal Examiner(s)	Prof. M. Madden *Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	4
Department(s)	Information Technology
Requirements	None

1. Assume that you have been contracted to implement a Distributed Banking System that consists of a server and some Automated Teller Machine (ATM) clients. The server manages all users' account information. A customer can invoke operations at an ATM that are then accessed, and implemented, on a server using Java RMI. Full implementation classes are not required for the server based remote objects but the answer should include the following:

   Write a Java interface called *BankServer* that provides provide methods for user login / authentication, deposit and withdrawal of funds, balance lookup and downloading a *Statement*. The user authentication will be based on using a unique session ID that acts as an authentication token that must be passed to the other methods. 7 MARKS

   Write a Java interface called *Statement* that provide methods for the retrieval of the transactions done on a particular bank account over a specified time period. Each individual transaction should be returned in a separate *Transaction* class that encapsulates details about each transaction. Include the source code for the *Transaction* class in your answer. 7 MARKS

   Provide the mainline server code required to fully initialise the server and then register an instance of the *BankServer* implementation class in the RMI Registry. 5 MARKS

   Provide a simple command line client program that will interact with the server as follows: (i) Login to the server. (ii) Deposit €100 to an account. (iii) Print the balance of an account. (iv) Download a Statement object for an account and print out the associated transactions. 6 MARKS

2.a: Outline the main differences between a *two-tier* and a *three-tier* Client-Server architecture. When would you recommend using a *three-tier* architecture? 5 MARKS

b: Web services represent an evolution and convergence of a number of important areas of technology and business. Describe these technology areas and explain how Web Services builds on previous capabilities. Include in your explanation an overview of the main enabling technologies used to provide Web Services. 10 MARKS

c: You have been asked to develop a commercial online bookstore using J2EE-based technologies. The bookstore architecture and design should be able to support different types of client browsers and should use a three-tier application model i.e. a client tier to support different clients, a middle tier that implements the application business logic and an information tier to persist the application state. Based on these requirements, describe the top-level application architecture. Identify the technologies that will be used and explain the role each of these technologies plays in the overall system architecture. 10 MARKS

3.a: What is *message oriented middleware* and what types of messaging models are available in the Java Messaging Service? 5 MARKS

b: You have been asked to design an application that allows weather updates on specific areas to be retrieved from a central web server and then forwarded periodically to interested client applications. Describe a suitable architecture and design for a distributed application that uses the Java Messaging Service (JMS) to handle the distribution of the weather update messages. Full Java source code is not required but your answer should provide a full description of how the JMS could be used within the application. Also describe how the application might use the Java Naming and Directory Interface (JNDI) as part of this solution. 10 MARKS

c: Assume that you have been contracted by a large multinational company to develop an enterprise class client / server application that may be accessed by a large number of clients concurrently. You will therefore need to employ some form of load balancing in the design of the application. What type of load balancing algorithm would you recommend? Are there any alternatives available? Provide technical justification and rationale for your recommendations. 10 MARKS

4.a: What types of services are typically available from commercial Cloud Computing providers? Provide some examples of each of these services in your answer. 5 MARKS

b: Suppose you work for a social media company that has very large unstructured data sets e.g. web logs or other application related data that needs to be stored and analysed. Also assume that the company has access to large scale computing resources based in multiple data centres. Explain how using the Apache Hadoop Distributed File System and its related facilities might help in solving this problem. Why is this a better solution than using traditional database systems? 8 MARKS

c: Describe in detail the MapReduce programming model. Outline the architecture for a MapReduce application that could be used to index a large number of text files by the individual words present in each file. Full source code for the application is not required but your answer should include the data structures that could be used and also clearly explain the purpose and functionality of the map() and reduce() functions in solving this problem. 12 MARKS

5.a: Explain the role of the Proxmox Virtualisation Environment. In this context, what is the difference between a Virtual Machine and a Container? 6 MARKS

b: How is it possible to run Virtual Machines at near native speed using Kernel-based Virtual Machine (KVM) infrastructure? 4 MARKS

c: What is the purpose of the Ceph storage platform and what advantages does it have over traditional RAID based storage? Describe the high level architecture and the main components of the Ceph storage platform. Include in this description details about the following items: Ceph Network, Object Storage Devices and Ceph Pools. 8 MARKS

d: What are the advantages of grouping physical servers into a cluster? How does a Proxmox cluster implement High Availability and what might cause a Virtual Machine migration to fail? 7 MARKS